

# Course software for Image Analysis with CNNs

You can do the practicals on various computing platforms. However, since the participants may use various types of computers and softwares, we recommend to use the UNIL JupyterLab to do the practicals.

- [JupyterLab](#): Working on the cloud is convenient because the installation of the Python packages is already done and you will be working with a Jupyter Notebook style. Note, however, that the UNIL JupyterLab will only be active during the course and for one week following its completion, so in the long term you should use either your laptop or Curnagl.
- [Laptop](#): This is good if you want to work directly on your laptop, but you will need to install the required libraries on your laptop. **Warning: We will give general instructions on how to install the libraries on your laptop but it is sometimes tricky to find the right library versions and we will not be able to help you with the installation.** The installation should take about 15 minutes.
- [Curnagl](#): This is efficient if you are used to work on a cluster or if you intend to use one in the future to work on large projects. If you have an account you can work on your /scratch folder or ask us to be part of the course project but **please contact us at least a week before the course**. If you do not have an account to access the UNIL cluster Curnagl, **please contact us at least a week before the course** so that we can give you a temporary account. The installation should take about 15 minutes. Note that it is also possible to use JupyterLab on Curnagl: see <https://wiki.unil.ch/ci/books/high-performance-computing-hpc/page/jupyterlab-on-the-curnagl-cluster>

If you choose to work on the UNIL JupyterLab, then you do not need to prepare anything since all the necessary libraries will already be installed on the UNIL JupyterLab. In all cases, you will receive a guest username during the course, so you will be able to work on the UNIL JupyterLab.

Otherwise, if you prefer to work on your laptop or on Curnagl, please make sure you have a working installation before the day of the course as on the day we will be unable to provide any assistance with this.

If you have difficulties with the installation on Curnagl we can help you, so please contact us before the course at [helpdesk@unil.ch](mailto:helpdesk@unil.ch) with subject: DCSR ML course.

On the other hand, if you are unable to install the libraries on your laptop, we will unfortunately not be able to help you (there are too many particular cases), so you will need to use the UNIL Jupyter Lab during the course.

Before the course, we will send you all the files that are needed to do the practicals.

# JupyterLab

Here are some instructions for using the UNIL JupyterLab to do the practicals.

Go to the webpage: <https://jupyter.dcsr.unil.ch/jupyter>

Enter the login and password that you have received during the course.

## Image Classification

We have already prepared your workspace, including the data and notebook. However, in case there is a problem, you can follow the following instructions.

Click on the button "New Folder" (the small logo of of folder with a "+" sign) and name it "models".

Click again on the same button "New Folder" and name it "images".

Double click on the "images" folder that you have just created.

Click on the button "Upload Files" (the vertical arrow logo) and upload the three images (car.jpeg, frog.jpeg and ship.jpeg) that are included in "images" directory you have received for this course.

Click on the folder logo (just on top of "Name") to come out of the "images" folder.

Double click on the "models" folder and then click on the button "Upload Files" to upload all the "models.keras" and "models.npy" files that are included in the "models" directory you have received for this course.

Click on the folder logo (just on top of "Name") to come out of the "models" folder.

To work with the html file "Convolutional\_Neural\_Networks.html":

- Click on the "CNN" square button in the Notebook panel
- Copy / paste the commands from the html practical file to the Jupyter Notebook

To work with the notebook "Convolutional\_Neural\_Networks.ipynb":

- Upload the notebook "Convolutional\_Neural\_Networks.ipynb"
- Double click on "Convolutional\_Neural\_Networks.ipynb"
- Change the "ipykernel" (top right button "Python 3 ipykernel") to CNN

In the practical code (i.e. the Python code in the html or ipynb file), the following paths were set:

```
platform = "jupyter"
```

```
PATH_IMAGES = "./images"
```

```
PATH_MODELS = "./models"
```

To execute a command, click on "Run the selected cells and advance" (the right arrow), or SHIFT + RETURN.

When using TensorFlow, you may receive a warning

```
2022-09-22 11:01:12.232756: W tensorflow/stream_executor/platform/default/dso_loader.cc:64]
Could not load dynamic library 'libcudart.so.11.0'; dLError: libcudart.so.11.0: cannot open shared
object file: No such file or directory
2022-09-22 11:01:12.232856: I tensorflow/stream_executor/cuda/cudart_stub.cc:29] Ignore above
cudart dLError if you do not have a GPU set up on your machine.
```

You should not worry. By default, TensorFlow is trying to use GPUs and since there are no GPUs, it writes a warning and decides to use CPUs (which is enough for our course).

When you have finished the practicals, select File / Log out.

## Image Segmentation

Now click on the "ImageProcessing" square button in the Notebook panel.

Copy / paste the commands from the html practical file to the Jupyter Notebook.

To execute a command, click on "Run the selected cells and advance" (the right arrow), or SHIFT + RETURN.

## Laptop

You may need to install development tools including a C and Fortran compiler (e.g. Xcode on Mac, gcc and gfortran on Linux, Visual Studio on Windows).

## Image Classification

Please decide in which folder (or path) you want to do the practicals and go there:

```
cd THE_PATH_WHERE_I_DO_THE_PRACTICALS
```

Then you need to create two folders:

```
mkdir images
mkdir models
```

Please copy/paste the three images (car.jpeg, frog.jpeg and ship.jpeg) that are included in the folder "images" you have received for this course in the "images" folder. And also copy/paste all the "models.keras" and "models.npy" files that are included in "models" directory you have received for this course.

In the practical code (i.e. the Python code in the html file), you will need to set the paths as follows:

```
platform = "laptop"
```

```
PATH_IMAGES = "./images"
```

```
PATH_MODELS = "./models"
```

Here are some instructions for installing Keras with TensorFlow at the backend (for Python3), and other libraries, on your laptop. You need Python  $\geq 3.8$ .

## For Linux

We will use a terminal to install the libraries.

Let us create a virtual environment. Open your terminal and type:

```
python3 -m venv mlcourse

source mlcourse/bin/activate

pip3 install tensorflow tf-keras-vis scikit-learn matplotlib numpy h5py notebook
```

You may need to choose the right library versions, for example tensorflow==2.12.0

To check that Tensorflow was installed:

```
python3 -c "import tensorflow; print(tensorflow.version.VERSION)"
```

There might be a warning message (see above) and the output should be something like "2.12.0".

You can terminate the current session:

```
deactivate
```

```
exit
```

## TO DO THE PRACTICALS (today or another day):

You can use any Python IDE (e.g. Jupyter Notebook or PyCharm), but you need to launch it after activating the virtual environment. For example, for Jupyter Notebook:

```
source mlcourse/bin/activate
```

```
jupyter notebook
```

## For Mac

We will use a terminal to install the libraries.

Let us create a virtual environment. Open your terminal and type:

```
python3 -m venv mlcourse
```

```
source mlcourse/bin/activate
```

```
pip3 install tensorflow-macos==2.12.0 tf-keras-vis scikit-learn matplotlib numpy h5py notebook
```

If you receive an error message such as:

```
ERROR: Could not find a version that satisfies the requirement tensorflow-macos (from versions: none)
```

```
ERROR: No matching distribution found for tensorflow-macos
```

Then, try the following command:

```
SYSTEM_VERSION_COMPAT=0 pip3 install tensorflow-macos==2.12.0 scikit-learn==1.2.2 scikeras eli5 pandas matplotlib notebook keras-tuner
```

If you have a Mac with M1 or more recent chip (if you are not sure have a look at "About this Mac"), you can also install the tensorflow-metal library to accelerate training on Mac GPUs (but this is not necessary for the course):

```
pip3 install tensorflow-metal
```

To check that Tensorflow was installed:

```
python3 -c "import tensorflow; print(tensorflow.version.VERSION)"
```

There might be a warning message (see above) and the output should be something like "2.12.0".

You can terminate the current session:

```
deactivate
```

```
exit
```

### TO DO THE PRACTICALS (today or another day):

You can use any Python IDE (e.g. Jupyter Notebook or PyCharm), but you need to launch it after activating the virtual environment. For example, for Jupyter Notebook:

```
source mlcourse/bin/activate
```

```
jupyter notebook
```

## For Windows

If you do not have Python installed, you can use either Conda:

<https://docs.conda.io/en/latest/miniconda.html> (see the instructions here:

<https://conda.io/projects/conda/en/latest/user-guide/install/windows.html>) or Python official

installer: <https://www.python.org/downloads/windows/>

We will use a terminal to install the libraries.

Let us create a virtual environment. Open your terminal and type:

```
python3 -m venv mlcourse
```

```
source mlcourse/bin/activate
```

```
pip3 install tensorflow tf-keras-vis scikit-learn matplotlib numpy h5py notebook
```

You may need to choose the right library versions, for example `tensorflow==2.12.0`

To check that Tensorflow was installed:

```
python -c "import tensorflow; print(tensorflow.version.VERSION)"
```

There might be a warning message (see above) and the output should be something like "2.12.0".

You can terminate the current session:

```
deactivate
```

### **TO DO THE PRACTICALS (today or another day):**

You can use any Python IDE (e.g. Jupyter Notebook or PyCharm), but you need to launch it after activating the virtual environment. For example, for Jupyter Notebook:

```
mlcourse\Scripts\activate.bat
```

```
jupyter notebook
```

## **Image Segmentation**

This part of the course must be done on the UNIL Jupyter Lab but some instructions on how to install the libraries on your laptop will be given at the end of the course.

## **Curnagl**

For the practicals, it will be convenient to be able to copy/paste text from a web page to the terminal on Curnagl. So please make sure you can do it before the course. You also need to make sure that your terminal has a X server.

For Mac users, download and install XQuartz (X server): <https://www.xquartz.org/>

For Windows users, download and install MobaXterm terminal (which includes a X server). Click on the "Installer edition" button on the following webpage: <https://mobaxterm.mobatek.net/download-home-edition.html>

For Linux users, you do not need to install anything.

When testing if TensorFlow was properly installed (see below) you may receive a warning

```
2022-03-16 12:15:00.564218: W tensorflow/stream_executor/platform/default/dso_loader.cc:64]
Could not load dynamic library 'libcudart.so.11.0'; dlerror: libcudart.so.11.0: cannot open shared
object file: No such file or directory; LD_LIBRARY_PATH:
/dcsrsoft/spack/hetre/v1.2/spack/opt/spack/linux-rhel8-zen2/gcc-9.3.0/python-3.8.8-
tb3aceqq5wzx4kr5m7s5m4kzh4kxi3ex/lib:/dcsrsoft/spack/hetre/v1.2/spack/opt/spack/linux-rhel8-
zen2/gcc-9.3.0/tcl-8.6.11-
aonlmtcje4sgqf6gc4d56cnp3mbbhvnj/lib:/dcsrsoft/spack/hetre/v1.2/spack/opt/spack/linux-rhel8-
```

```
zen2/gcc-9.3.0/tk-8.6.11-  
2gb36lqwohtzopr52c62hajn4tq7sf6m/lib:/dcsrsoft/spack/hetre/v1.2/spack/opt/spack/linux-rhel8-  
zen/gcc-8.3.1/gcc-9.3.0-  
nwqdwvso3jf3fgygezygmtty6hvydale/lib64:/dcsrsoft/spack/hetre/v1.2/spack/opt/spack/linux-rhel8-  
zen/gcc-8.3.1/gcc-9.3.0-nwqdwvso3jf3fgygezygmtty6hvydale/lib  
2022-03-16 12:15:00.564262: I tensorflow/stream_executor/cuda/cudart_stub.cc:29] Ignore above  
cudart dlerror if you do not have a GPU set up on your machine.
```

You should not worry. By default, TensorFlow is trying to use GPUs and since there are no GPUs, it writes a warning and decides to use CPUs (which is enough for our course).

## Image Classification

Here are some instructions for installing Keras with TensorFlow at the backend (for Python3), and other libraries, on the UNIL cluster called Curnagl. Open a terminal on your laptop and type (if you are located outside the UNIL you will need to activate the UNIL VPN):

```
ssh -Y < my unil username >@curnagl.dcsr.unil.ch
```

Here and in what follows we added the brackets < > to emphasize the username, but you should not write them in the command. Enter your UNIL password.

For Windows users with the MobaXterm terminal: Launch MobaXterm, click on Start local terminal and type the command `ssh -Y < my unil username >@curnagl.dcsr.unil.ch`. Enter your UNIL password. Then you should be on Curnagl. Alternatively, launch MobaXterm, click on the session icon and then click on the SSH icon. Fill in: remote host = `curnagl.dcsr.unil.ch`, specify username = `< my unil username >`. Finally, click ok, enter your password. If you have the question "do you want to save password ?" Say No if your are not sure. Then you should be on Curnagl.

See also the documentation: <https://wiki.unil.ch/ci/books/high-performance-computing-hpc/page/ssh-connection-to-dcsr-cluster>

You can do the practicals in your `/scratch` directory or on the course group "cours\_hpc" if you have asked us in advanced:

```
cd /scratch/< my unil username >  
  
or  
  
cd /work/TRAINING/UNIL/CTR/rfabbret/cours_hpc  
mkdir < my unil username >  
cd < my unil username >
```

You need to make two directories:



```
mkdir images
```

```
mkdir models
```

Clone the following git repos:

```
git clone https://c4science.ch/source/CNN_Classification.git
```

Copy the images from CNN\_Classification to images:

```
cp CNN_Classification/*.jpeg images
```

You also need to upload all the "models.keras" and "models.npy" files that are included in the "models" directory you have received for this course, and move them to the "models" folder on Curnagl.

Let us install libraries from the interactive partition:

```
Sinteractive -m 10G -G 1
```

```
module load python/3.10.13 cuda/11.8.0 cudnn/8.7.0.84-11.8
```

```
python -m venv mlcourse
```

```
source mlcourse/bin/activate
```

```
pip install -r CNN_Classification/requirements.txt
```

To check that TensorFlow was installed:

```
python -c 'import tensorflow; print(tensorflow.version.VERSION)'
```

There might be a warning message (see above) and the output should be something like "2.9.1".

You can terminate the current session:

```
deactivate
```

```
exit
```

**TO DO THE PRACTICALS (today or another day):**

```
ssh -Y < my unil username >@curnagl.dcsr.unil.ch
```

```
cd /scratch/< my unil username >
```

or

```
cd /work/TRAINING/UNIL/CTR/rfabbret/cours_hpc/< my unil username >
```

You can do the practicals on the interactive partition:

```
Sinteractive -m 10G -G 1
```

```
module load python/3.10.13 cuda/11.8.0 cudnn/8.7.0.84-11.8
```

```
source mlcourse/bin/activate
```

```
python
```

In the practical code (i.e. the Python code in the html file), you will need to set the paths as follows:

```
platform = "curnagl"
```

```
PATH_IMAGES = "./images"
```

```
PATH_MODELS = "./models"
```

## Image Segmentation

On demand. If you work in a project in which you need to use Curnagl to do segmentations, please contact us.

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